# High throughput phenotyping method for water use efficiency in rice field

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## Introduction :

A collaborative CIAT/Cirad project aims to create new improved upland rice germplasm for drought tolerance based on population improvement (Guimarães, 2005) through recurrent selection (RS). In the framework of a multidisciplinary team (ecophysiology, molecular genetics and breeding), we seek to enhance this breeding strategy through the integration of marker assisted breeding tools. This requires improving methods for high throughput phenotyping in the field.

## Material and methods :

Hundreds lines selected from diverse breeding populations managed through RS were screened under drought conditions in Villavicencio CIAT experimental station (Colombia) during the dry season. Lines were distributed following an alpha lattice design with two treatments including checks in each sub-block. Drought was applied during two weeks. Drought response under water deficit was evaluated based on soil moisture, canopy temperature and final grain yield. Lines were phenotyped with infra-red thermographic camera for leaf temperature (Fig 1), a variable closely related to transpiration rate under given weather conditions (Turner et *al.*, 1986; Garrity and O'Toole, 1995; Laffite et *al.*, 2003). Canopy temperature measurements were conducted at beginning, mid and end of stress period, close to noon on sunny days to minimize temporal variability.

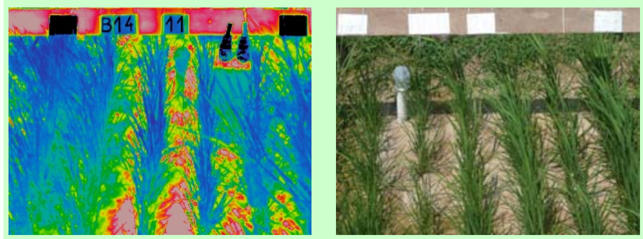


Fig. 1: Thermographic and simultaneous visual pictures (Villavicencio, Colombia, 2010).

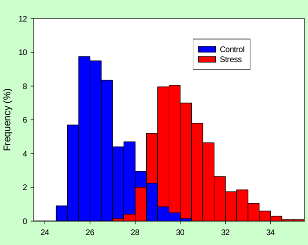


Fig. 2: Canopy temperature frequency histogram for 400 lines (Villavicencio, Colombia, 2009).

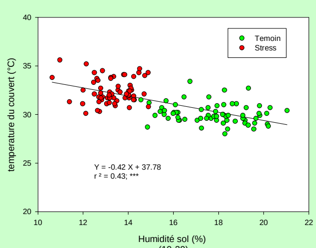


Fig. 3: Relationship between canopy temperature and soil humidity; (Villavicencio, Colombia, 2008).

## Results :

Leaf temperature exhibited strongly significant varietal differences (Fig 2) that were negatively correlated with soil moisture content (Fig 3) and yield, thus enabling effective phenotyping with moderate investment. This phenotyping approach permitted identifying genotypes that display sufficient transpiration level (and thus sustained growth) under drought stress, related mainly to limited water extraction and/or greater root depth; it also enabled us to identify genotypes that have high transpiration rates (and thus higher potential growth rates) under irrigated control conditions. Selecting suitable combinations of both characteristics is expected to help identify drought tolerant material with high yield potential (Fig 4).

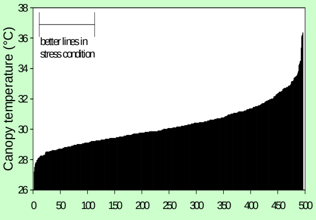


Fig. 4: Canopy temperature for the 400 lines in stress condition (Villavicencio, Colombia, 2009).

## Discussion and Conclusion :

The methodology is currently improved by (1) including on each thermographic picture a wet/dry object to normalize canopy temperatures against weather fluctuations in situations were micro-meteorological backup is not available, (2) standardizing lines canopy temperature with method based on the Vapor Pressure Deficit and Crop Water Stress Index, and (3) sampling leaf material for complementary delta 13C measurements indicative of transpiration efficiency (TE).

Numerical thermographic cameras have a great potential for high throughput phenotyping for water use efficiency in the field. Screening rice germplasm using this methodology will be implemented for RS breeding as well as for genetic studies in order to identify promising genomic regions and polymorphisms for marker development.

## References :

**Garrity, D.P. and O'Toole J.C.** 1995. Agron. J. 87:773–779.
**Guimarães E.P.,** 2005. FAO. 350 p.
**Lafitte R, Blum A. and Atlin G.** 2003. IRRI 37-48.
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